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**Coalition Interoperability: Not another Technological Solution**

by

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A paper submitted to the Faculty of the Naval War College in partial satisfaction of the requirements of the Department of Joint Military Operations.

The Contents of this paper reflect my own personal views and are not necessarily endorsed by the Naval War College or the Department of the Navy.

Signature:\_\_\_\_\_

14 February 2005

Abstract of

Coalition Interoperability: Not another Technical Solution

Coalition interoperability has been an issue for some time. One can look back through history from WWI to present and determine that coalitions are the norm and not the exception. There are numerous articles on how technical solutions are available to increase interoperability. However, coalition interoperability continues to be a problem. If the operational commander understands the scope of interoperability, the limiting factors of interoperability and the current operational trends to achieve interoperability one can conclude that technology, by itself, will not solve interoperability.

However, technology as a key contributor to the achievement of interoperability; the operational commander must balance between technology and information to gain an acceptable level of interoperability. Several options are available that do not specifically address technology. The operational commander can begin to forecast how future operations will take place. Specifically, how the GWOT and Network Centric Warfare might change the nature of multinational operations and establish a coalition component as part of the JTF structure. The operational commander can transition to a coalition information network to change the paradigm in the U.S. military from a U.S. only information organization to truly a coalition-oriented force. Finally, the operational commander can continue to focus on combined training designed to increase the information aspects of interoperability as operational objectives. These recommendations recognize that technology will contribute to interoperability but will not provide the commander the final solution.

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On 26 December 2004, an 8.9 magnitude earthquake, off the northwest coast of Sumatra, Indonesia, created a tsunami in South East Asia causing massive destruction to the countries of Indonesia, Thailand, India, Sri Lanka and the west coast of Africa. Immediately, political, military, and humanitarian support agencies began crisis action planning to conduct disaster relief operations in the devastated areas. The Standing Joint Task Force Headquarters (SJTFHQ) at U.S. Pacific Command (US PACOM) began coordinating with potential coalition members and established a web site on the Combined Enterprise Regional Information Exchange System (CENTRIXS) network. Government and military leaders from Thailand, Philippines, Japan, Republic of Korea, Australia, New Zealand, Italy, United Kingdom, France, Germany, Saudi Arabia, and Yemen were able to see a common operational picture, participate in collaborative planning, review imagery and coordinate planning efforts through a web based communication network.

As the Combined Support Force 536 (CSF-536) prepares to deploy, the coalition begins to take shape. CSF-536 is able to pass information to multiple coalition partners on one network from garrison locations. Upon arriving in theater, the Commander of CSF-536 sits at his desk to draft an update to the US PACOM commander. On his desk, there is one computer and one telephone. As the commander moves into the Joint Operations Center he observes service members from Australia, Bangladesh, Republic of Korea, Malaysia, Germany, France, Great Britain, Pakistan, Australia, Indonesia, Singapore, New Zealand, and United States behind single computer terminals and on the phones coordinating relief efforts. The General stops and talks to a Republic of Korea (ROK) Marine. Using a translation system, on the computer, the ROK Marine is able to provide an update on when ROK aircraft will be arriving to support one of the Combined Support Groups.

The tragic events in South East Asia are reality; however, the coalition interoperability portions are fiction. One can change the above scenario to fit within any spectrum of warfare, from Military Operations other than War (MOOTW) to full-scale combat. The recurring theme is that coalitions will continue in the future. As stated in the National Security Strategy (NSS),

"Alliances and multilateral institutions can multiply the strength of freedom-loving nations. The United States is committed to lasting institutions like the United Nations, the World Trade Organization, the Organization of American States, and NATO as well as other long-standing alliances. Coalitions of the willing can augment these permanent institutions."<sup>1</sup>

Therefore, an implied task, from the NSS, is that interoperability between U.S. and coalition members is a requirement to "multiply the strength of freedom loving nations" and facilitate information sharing.

However, the ability for U.S. forces to interoperate seamlessly with coalition partners has been a stated requirement and has yet to be satisfied.<sup>2</sup> In two different SIGNAL magazine articles, by Robert Ackerman, both the U.S. Central Command J6 and the United Kingdom joint forces communication and information systems commander in Iraq, identified coalition information sharing as problematic due to the lack of interoperability between the two forces.<sup>3</sup> Additionally, U.S. Central Command has installed "three global and three regional, completely separate networks for coalition COI [Community of Interest] sharing. Each network is built to the same enterprise standard, but cannot be interconnected."<sup>4</sup> If the U.S. "enjoys a position of unparalleled military strength and great economic and political influence,"<sup>5</sup> why is there still a problem with interoperability among coalition and allied members? One answer to this question is that technology is not the only solution to interoperability and the operational commander must determine level of interoperability

required to achieve the operational and strategic objectives. To determine this level the commander must understand the scope of the problem, limiting factors and operational trends. The commander can begin to achieve an acceptable level of interoperability through changing Joint Task Force (JTF) organizational structure, changing organizational paradigms, and conducting focused training. Each of these above points has a temporary and long-standing potential to achieve coalition interoperability without relying on new technological solutions.

## SCOPE OF INTEROPERABILITY

To understand why the U.S. is still attempting to achieve this operational requirement one must appreciate the scope of interoperability. Additionally, the operational commander (Combatant Commander or JTF Commander) will not be able to correct or influence all aspects of the problems associated with interoperability. A general understanding of the scope of the problem is required to establish a foundation for further analysis. William Skidmore and Daniel Klingenborg, identified two points, communications and information, that affect coalition interoperability.<sup>6</sup> This paper expands on their concepts and identifies these points as interoperability pillars, first being technology and second being information.

### Pillar One: Technology

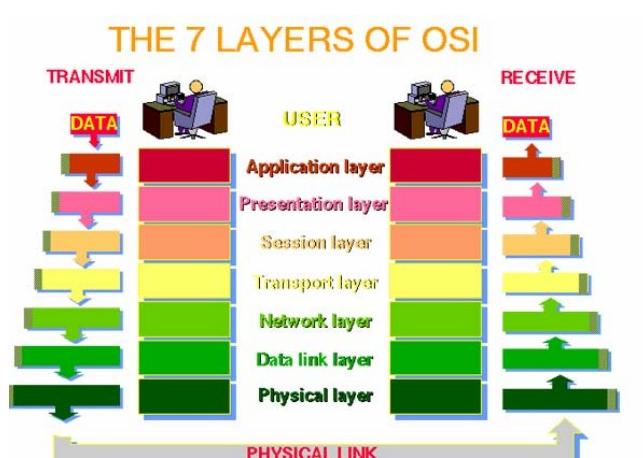


Figure 1: OSI Model <[http://www.webopedia.com/quick\\_ref/OSI\\_Layers.asp](http://www.webopedia.com/quick_ref/OSI_Layers.asp)>

Technology is the most visible aspect of coalition interoperability. Using the seven layers of the Open System Interconnection (OSI) model, see figure 1, one can see the complexity of making equipment interoperate. Include the technological

development of nation specific information systems, designed to achieve nation specific operational and strategic objectives, only increases the complexity of the problem. The director of interoperability in the Office of the Secretary of Defense is specifically addressing U.S. internal interoperability issues, and the plan to gain U.S. internal interoperability includes coalitions from the strategic to the tactical level.<sup>7</sup> However, this remains focused on the technological aspects of interoperability.

The commercial sector influences interoperability. The global evolution of the Microsoft Windows operating system and a standard hardware/network configuration based on Transmission Control Protocol/Internet Protocol (TCP/IP)<sup>i</sup> standards have decreased the problems associated with interconnecting coalition member's systems to coalition networks. This evolution only addresses the ability for the user to gain access to certain command and control applications. The point of referring to the OSI model is to impress on the reader that a technological solution to the problem contains multiple layers. Specifically, the OSI model starts and ends with the user who requires the information.

## **Pillar II: Information.**

Referring to figure 1, the user receives information and turns this into knowledge at a speed that is dependant on the user's language, culture, and experience. Relating this point to a military application, the Department of Defense (DoD) defines a coalition as "an ad hoc arrangement between two or more nations for common action."<sup>8</sup> To obtain the operational

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<sup>i</sup>TCP/IP is defined according to the University of Berkley as "a suite of protocols that defines the Internet. Orginally designed for the UNIX operating system, TCP/IP software is now available for every major kind of computer operating system. To be truly on the Internet, your computer must have TCP/IP software." <<http://www.lib.berkely.edu/TeachingLib/Guides/Internet/Glossary.html>> [4 Feb 2005].

objective the coalition members must understand the information to develop this common action.

An obvious limitation to developing common action is language. The U.S. currently participates in numerous interoperability and transformation boards consisting of foreign nations. One such board, the Combined Communication Electronic Board (CCEB) is a five-nation board consisting of U.S., U.K., Australia, New Zealand and Canada. The CCEB's purpose is "to maximize the effectiveness of the Warfighter in Combined Operations by delivering capabilities, policies, procedures and radio spectrum that optimizes information and knowledge sharing."<sup>9</sup> This board focuses on strategic and operational level issues.<sup>10</sup> The common language of the CCEB members facilitates a common understanding of interoperability requirements at the technical and informational pillars.

However, as stated in the definition of a coalition, the ad hoc nature may not allow the U.S. to operate in a coalition with a common language base line. For example, Thailand's primary language is Thai and for the elites, English is a secondary language. Additionally, the Thai language is further divided into regional and ethnic dialects.<sup>11</sup> Why is this important? According to the CIA Fact Book, Thailand's compulsory military service produces approximately five hundred thousand military members annually.<sup>12</sup> The ability to share information with Thailand might be achievable via technology but the ability to translate information to knowledge from the operational to tactical level has the potential to be limited. Granted, this is a generalization of Thailand; replace Thailand with any US PACOM country and there is an immediate hurdle of language and culture to overcome to achieve common actions toward the operational objective.

## **Foundation: DoD Definition**

When constructing a house, one of the first steps is to lay the foundation to support further construction. The same is true when referencing the two pillars of interoperability. To support the technology and information pillars one must establish a foundation based on a common understanding of basic principles and concepts. The foundation for these two pillars is doctrine. The DoD definition for interoperability is the foundation of this paper.

"The ability of systems, units, or forces to provide services to and accept services from other systems, units, or forces and to use the services so exchanged to enable them to operate effectively together. DOD only, The condition achieved among communications-electronics systems or items of communications-electronics equipment when information or services can be exchanged directly and satisfactory between them and/or their users. The degree of interoperability should be defined when referring to specific cases." [Emphasis added]<sup>13</sup>

This definition accounts for both technology and information requirements to achieve interoperability. The definition recognizes that the achievement of interoperability does not require full interoperability down to the tactical level. As the scope of interoperability is immense, the operational commander should focus on the level of interoperability required to achieve common action for each specific coalition.

## **LIMITING FACTORS**

Even with a solid foundation, there are limiting factors that slow the interoperability process. Three of these factors are nation policies, nation economics, and time. These factors are not new and need consideration, as they will affect the commander's ability to determine and establish the level of interoperability required for the coalition.

### **Nation Policies**

At the strategic level, the nature of a coalition does not allow for long-standing political agreements and the development of trust between coalition members. Specifically,

as the DoD definition indicates, the ad hoc nature of coalitions is a temporary arrangement to achieve the common objective. This temporary arrangement might limit the willingness to share national information between coalition members. The U.S. has established policy on how to release intelligence information to foreign nations via the National Disclosure Policy 1 (NDP-1). This document should be the guide for the operational commander to establish the degree of interoperability. During Desert Storm, General Schwarzkopf decided to share intelligence data with coalition members without regard to this policy.<sup>14</sup> One can argue that this was a necessary decision by the operational commander to achieve the strategic objective. However, the commander must protect U.S. national interest and avoid damaging current and future coalitions through these actions. The operational commander cannot directly change the national policy and must consider this factor when determining the level of interoperability required within a coalition.

### **Nation Economics**

The operational commander cannot change the increasing technology gap between the U.S. and potential coalition members. U.S. technological innovation and augmenting operational concepts are required to evolve into the next generation of warfare. The U.S. should not slow down the progression of operational concepts based on coalition limitations, but the operational commander must consider this limitation when incorporating coalition partners. A report by Northrop Grumman states, the U.S. is showing a trend of selecting coalition partners based not on the combat potential they bring to the battle space but on the financial and access privileges these nations possess.<sup>15</sup> The operational commander can

influence the technology gap by the Theater Security Cooperation Plan.<sup>ii</sup> However, the commander's ability to change the priorities of a foreign nation's economic policies will primarily focus on the technology pillar and not support the information pillar.

## **Time**

The final limiting factor is the ability to timely place new technology with the operational commander. The Coalition Warrior Interoperability Demonstration (CWID) is an annual exercise tasked to support the operational commander's interoperability requirements and provide "solutions to near-term coalition challenges."<sup>16</sup> However, by looking at the history of CWID from 1994 to 2003, it is clear that the objectives have focused mainly on how to share information securely with coalition partners. In a statement on Operation Iraqi Freedom Lessons Learned, to the House of Armed Services Committee, Admiral Giambastini, US JFCOM, stated, "Capabilities that fell short of expectations or requiring new initiatives to redress shortfalls include: Battle Damage Assessment, Fratricide Prevention, Deployment planning and execution, reserve mobilization, and coalition information sharing."<sup>17</sup> This indicates that the time taken to test, validate, accredit and field new systems is not supporting the operational requirement. The limiting factor is that new solutions might be available to satisfy both the information and technology pillars but the time to incorporate these systems, coupled with the rate of advance in technological innovation, makes this no longer a viable option.

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<sup>ii</sup> The Joint Forces Operational Warfighting SMARTBOOK identifies the Theater Security Cooperation Plan (TSCP) as a plan developed by combatant commanders to "support the U.S. defense strategy, advance regional defense policy goals, and in the immediate term, enable the war on global terrorism" with allies and potential coalition members. (The Joint Forces Operational Warfighting SMARTBOOK, The Lightning Press, 2003, 4-43).

## **OPERATIONAL LEVEL TRENDS**

Comparing past exercises and operations one can identify trends that the operational commanders are developing to address the coalition interoperability issue. Dividing these operational trends into three time-based categories identifies that: short-term trends are solutions that the operational commander is implementing to achieve immediate interoperability; mid-term trends are solutions that the operational commander is influencing and/or planning to incorporate; long-term trends are solutions that have either unplanned or unknown potential.

### **Short-Term**

One short-term solution the operational commanders are using to achieve coalition interoperability is the employment of liaison officers (LNO). This proven concept allows for the exchange of both technology and information between coalition members and establishes a limited, point-to-point, level of interoperability. During Operation IRAQI FREEDOM, US CENTCOM relied on LNO's at the tactical level to gain coalition interoperability.<sup>18</sup> Additionally, in Operation IRAQI FREEDOM, the LNO concept expanded to include LNO C2 equipment. The U.K. Royal Navy accessed information on SIPRNET via a U.S. C2 system with the LNO providing the security and operation of the terminal.<sup>19</sup> As future combat operations become more technologically advance and operational concepts mature, the impact to the JTF commander will be an increased requirement for liaison officers thus straining the JTF for more personnel and equipment to support coalition operations.

Another solution operational commanders are using to achieve interoperability is the establishment of unique coalition networks. These networks have been present for some time and as the number of coalition operations has increased, the number of coalition networks

has increased in stride. US PACOM, during Exercise COBRA GOLD, installed three completely different coalition networks over three years. The trend is that commanders are establishing multiple ad hoc networks to achieve short-term interoperability without meeting long-term requirements. The impact to the JTF commander is the increased requirement to provide more equipment and personnel to support these separate networks. Additionally, a JTF commander may risk the inadvertent release of U.S. only information on coalition networks as the JTF and components transfer data between networks.

Another short-term trend, as pointed out in the Northrop Grumman report, is the technology gap between the U.S. and potential coalition partners. The selective nature of building coalitions due to financial and access right as opposed to combat power will create niche type roles for coalition members.<sup>20</sup> The impact to the operational commander is how to incorporate and designate operational tasks for coalition partners with only limited interoperability.

### **Mid-Term.**

A mid-term solution is the development of the Multinational Information Sharing (MNIS) Combined Enterprise Regional Exchange System (CENTRIXS), which is a strategic initiative, based on operational commanders stated requirements.<sup>21</sup> The guidelines for MNIS CENTRIXS are contained in DOD instruction 8110.1 and the program goal is that "MNIS CENTRIX-equipped Forces shall be able to 'plug and play' anywhere in the world."<sup>22</sup> The operational concept is for the combatant commanders to maintain control of regional networks while using a common standard to link different regions globally via the global information grid.<sup>23</sup> The instruction further tasks the National Security Agency to develop the solution to connect U.S. only networks to MNIS CENTRIXS. The operational trend is the

centralization of standards for all regional commanders, and the impact to the JTF commander is centralized access to multiple networks. MNIS CENTRIXS has the potential to reduce equipment and personnel requirements in a deployed environment.

During CWID 2003, a US PACOM sponsored mid-term solution called the Agile Coalition Environment (ACE) was tested. ACE provides the commander with the ability to link multiple networks from a central point and, via single client terminals, access different levels of information based on a user profile.<sup>24</sup> The CWID after action report stated, ACE is a "usable, flexible tool suitable for tactical deployment."<sup>25</sup> Additionally, US PACOM is planning to incorporate ACE into the SJTFHQ allowing the commander to access US Secret, CENTRIXS Japan, CENTRIX Korea, 4-eyes, and Global Counter Terrorism Task Force via a single terminal.<sup>26</sup>

### **Long Term.**

The long-term solution available to the operational commander does not focus on technology but focuses on continuous combined training directed towards a common threat. The UK Ministry of Defense noted that Royal Air Force and Royal Navy participation in enforcement of UN Sanctions in Iraq directly contributed to their successful integration of combat forces during Operation Iraqi Freedom.<sup>27</sup> The training conducted in anticipation of combat operations produces a measure of success towards interoperability and the UK report further noted that Exercise INTERNAL LOOK 2002, prepared the UK headquarters staff for coalition operations.<sup>28</sup> The long-term trend is that continuous combined training and operations allows coalition partners to gain a level of interoperability through experience on the battlefield. The U.K. has identified this trend, in reference to the Iraqi No Fly Zones, and states in the report, "It will be a considerable challenge to find suitable training opportunities

to maintain the momentum of integrated coalition activity for future aircrew and support personnel.<sup>29</sup> The impact to the operational commander is how to develop regional training that provides a realistic environment to increase coalition experience and facilitate interoperability.

## **RECOMMENDATIONS**

### **Recommendation 1.** Combined forces Component Command (COFOR)

According to Joint Publication 0-2, the operational commander can organize a JTF by service or functional component or a combination of the two components.<sup>30</sup> Additionally, Joint Publication 0-2, describes and depicts the elements of a notional multinational operations command structure. The recommendation to organize a combined forces component command is a combination of these two doctrinal approaches to the organization of a JTF. The combined forces component command will facilitate interoperability by centralizing the technological and informational aspects of the interoperability problem. The organization of the component command can be similar to multinational operations with a multinational forces commander or can be a U.S. led organization. The change is that multinational operations become a subset of the JTF organization. The operational commander of the JTF can designate the degree of interoperability required based on the coalitions capabilities which in turn will determine the mission and tasks that this component might perform in support of the objective.

The advantages of this organizational change are numerous. First, in the short-term, the JTF commander is able to identify the level of interoperability required based on the coalition components capability. Full interoperability is not required and the JTF as whole will be able to focus on obtaining the operational or strategic objective. Second, as the

technology gap increases and the U.S. military evolves into the information age of command and control, as stated in Power to the Edge, by David Alberts and Richard Hayes, the US will retain the ability to be backwards compatible with industrial command and control coalition nations,<sup>31</sup> thus allowing Network Centric Operations to evolve. A long-term benefit of this type of organization is the coordinated development of doctrine, training and technology advances. Specifically, coalition component doctrine can focus on specific missions and Theater Security Cooperation Plans can target these missions. In the future, when Network Centric Warfare (NCW) becomes a reality, instead of each country developing independent concepts of NCW to interoperate with U.S. war fighting functions, the operational commander can influence how potential coalition members can enhance JTF common actions as a component of the JTF.

The disadvantages of this recommendation are just as numerous as the advantages. This type of organization only supports U.S. led operations and does not support multinational operations doctrine. Additionally, this recommendation will not work in every situation. However, the intention of this recommendation is not to push the interoperability problem into the corner but provide the commander with the ability to focus coalition training within the region and standardizes the Combined Joint Task Force concept. As long as the U.S. takes a leading role in the Global War on Terrorism, new concepts and norms about multinational operations will begin to develop through experience and time. Therefore, there is a potential that future multinational operations might be completely different in the future. This recommendation recognizes this potential for future change and provides an option for the commander to gain interoperability with coalition partners.

**Recommendation 2.** Establish MNIS CENTRIXS as the primary network.

Based on the limiting factors as stated in this paper, the requirement to maintain regional networks will not disappear due to the concern to protect U.S. national interest. However, in deployed environments, the installation of ad hoc coalition networks to support operations and exercises are becoming the primary network for the JTF. The operational commander should designate MNIS CENTRIXS as the primary U.S. network for day-to-day operations, not only in deployed environments but also in garrison environments. By designating MNIS CENTRIXS as the primary network, the regional combatant commanders and subordinate commands have the potential to evolve into a coalition environment instead of a U.S. only environment during day-to-day operations. Just as SIPRNET has evolved to become the primary network to share U.S. only Secret and below information between strategic, operational and tactical users, MNIS CENTRIXS could evolve to become the primary network between these levels of command.

The hierachal nature of the military will allow for this transition. The transition of the combatant commander will force subordinate commands and strategic supporting commands into transition to ensure the information reaches the intended user. For example, the transition to Microsoft Word as the primary word processor was a top down form of change. Every service initially operated on a different standard, but once the higher headquarters established a new standard, the subordinate commands changed to facilitate sharing information. Applying the OSI model, the operational commander sets the standards for the users.

The potential benefit of this recommendation is an acceleration of augmenting technological solutions. As long as the operational commander uses traditional U.S. only

networks, for day-to-day operations, the supporting staffs of both strategic and tactical forces will focus procurement, doctrine, and training to operate on this network and not on the integration of coalition networks. If the operational commander operates on the currently deployed network, the paradigm will shift thus turning the traditional U.S. only networks into secondary supporting networks and MNIS CENTRIXS into the primary network.

The potential negative aspects of this change are inconvenience and time. There will be a period where multiple machines will be sitting on the commander's desk. The commander and staff will be required to transfer information between these systems until all service components and strategic supporting agencies make this transition. However, by focusing on subordinate commands the operational commander will have the ability to form JTF's that are familiar with operating on coalition networks, have a repository of information on these networks and know the policies and procedures to share information on these networks. This recommendation will reduce a fraction of the friction already facing a combined JTF. US PACOM's ACE program is a good standard to begin this transition.

### **Recommendation 3. Focused Training**

Identified as a long-term trend, training and operating in a coalition against a common threat has been the most successful contribution to coalition interoperability. Through the development of the Theater Security Cooperation Plan, the operational commander should identify measures of effectiveness specifically relating to coalition interoperability. The measures of effectiveness can translate to operational level training objectives. However, to achieve success the commander must formulate objectives that have value towards the information and technology pillars of interoperability. At the conclusion of every JTF level exercise the operations order for the scenario needs updating based on the events of the

exercise. Not every exercise should become a concept plan but the requirement for all staff sections to participate and update the combined operations order closes the gap between the technology and informational pillars. For example, the C6 staff's focus of effort for Exercise COBRA GOLD is on staff and real world exercise support. The C6 does not produce any coalition products to support planning and execution from the scenario. By making this change, the staff sections exercise a portion of the plan with coalition partners; produce an output based on the scenario; and develop a common understanding of the requirements of coalition partners to obtain the operational objective.

Identified in the long-term operational trends, the advantage of focused training with coalition partners facilitates interoperability. The U.K. participation in Exercise INTERNAL LOOK 02 was not the first exercise that the U.K. and U.S. conducted with each other. However, two variables were different. First, there was the potential for the exercise to become combat operations and second the updated products identified potential weakness. Therefore, one can conclude from the above statement, the potential for combat operations increased the importance and focus of effort on interoperability between these two nations than previous exercises.

The disadvantage of this recommendation is the potential inability of the JTF commander to gain support from the coalition partners. U.S. participants will follow the lead of the commander. However, coalition participation relates to how the coalition commander focuses the staff and subordinate commands. JTF Commanders might not be able to produce the level of detail required to satisfy the commander's measure of effectiveness.

## **CONCLUSION**

Coalition interoperability is an elusive target. The scope of interoperability is overwhelming and one can quickly begin to realize that technology is not the only solution to achieve interoperability. Granted, technology will provide the operational commander the ability to interconnect communication networks and reduce the number of coalition networks present today, but this technology has proven to be only a mid-term solution and does not satisfy the immediate requirement. When the operational commander is determining the level of interoperability required to operate with a coalition, the commander must recognize both pillars of interoperability and should state the level of interoperability he or she requires for each coalition. The commander can do this by organizing the JTF with a coalition component command, by establishing a coalition network as the primary network, and by increasing the measure of effectiveness contained in the Theater Security Cooperation Plan. If the commander does not focus on the level of interoperability required and does not balance between technology and information, the gap between the U.S. and future coalition partners will continue to increase in the future.

## NOTES

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<sup>1</sup> President, U.S., The National Security Strategy of the United States of America, Washington, DC: September 2002, iii.

<sup>2</sup> Boardman, Jill L. and Shuey, Donald W., Combined Enterprise Regional Information Exchange System (CENTRIXS); Supporting Coaliton Warfare World-Wide, April 2004, USCENTCOM,  
<[http://www.dodccrp.org/events/2004/ICCRTS\\_denmark/cd/papers/003.pdf](http://www.dodccrp.org/events/2004/ICCRTS_denmark/cd/papers/003.pdf)> [7 Jan 2004], 3.

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<sup>4</sup> Boardman and Shuey, 3.

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